ROADSIDE SAFETY

&

GUARDRAIL DESIGN

PRESENTATION

- ROADSIDE SAFETY
  - Clear Zone & Obstruction Free Zone
  - Treatment of Obstructions
  - Construction CZ
- GUARDRAIL DESIGN
  - GR Placement
  - GR Design for 3R Projects
  - GR at Large Structures
- Design Exceptions
- Common Mistakes & Omissions
- Practice Pointers

Clear Zone Concept

- Space for Vehicles Run-off-the-Road to ***Gain Control***
- Amount of Obstruction-Free Area for ***Vehicle Recovery***
- Like “Airport Runway” - Free of Obstructions
- Place Roadside Hazards Away from Pavement

Clear Zone Applicability

- New Construction & Reconstruction
- 3R/Partial 4R on Interstates
- Desirable for 3R
- Cost Effectiveness of Corrective Measures
- Clear Zone values are not absolute
- CZ Outside R/W – Use R/W
- Engineering Judgment
- Provide Consistent CZ
- Level 2 Design Exception

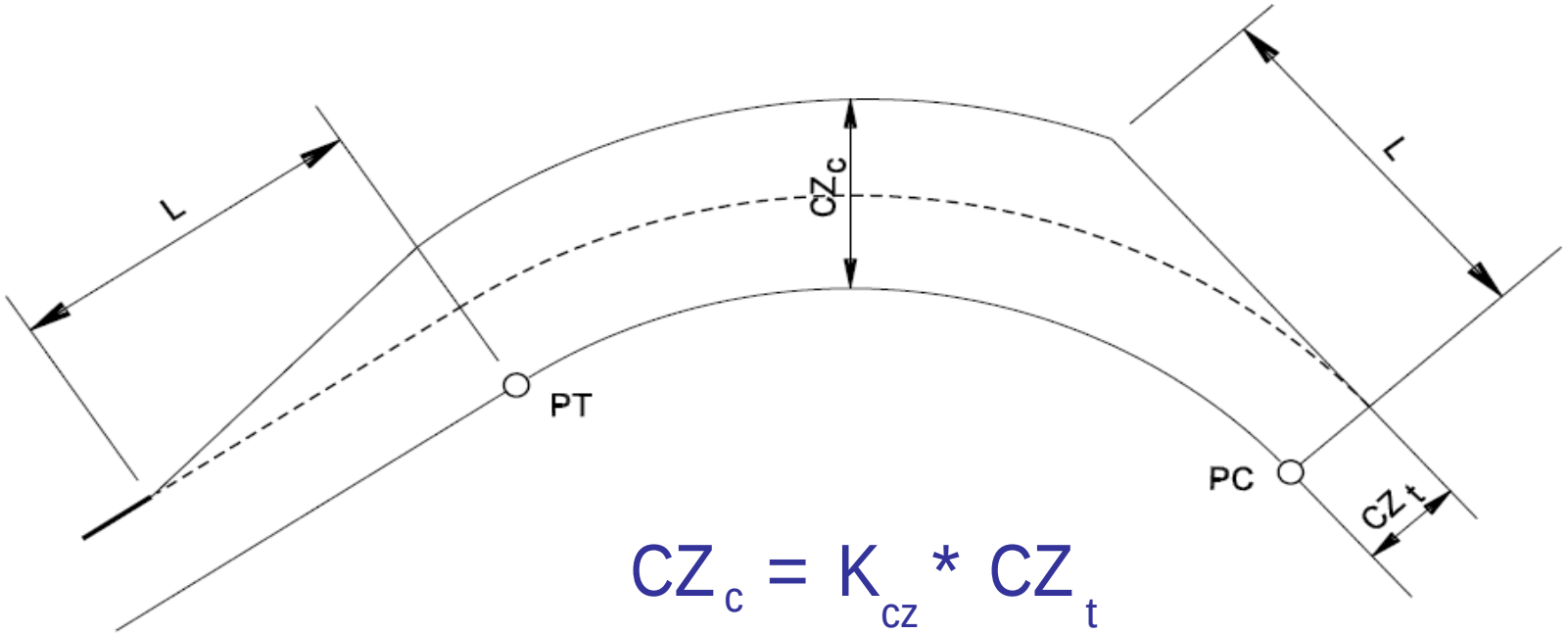
Clear Zone Distances

Design Speed (mph)	Design Year AADT "T"	Foreslopes		Backslopes		
		6:1 or Flatter	5:1 or 4:1	3:1	4:1 or 5:1	6:1 or Flatter
≤ 40	< 750	7 – 10	7 – 10	7 – 10	7 – 10	7 – 10
	750 ≤ T < 1500	10 – 12	12 – 14	10 – 12	10 – 12	10 – 12
	1500 ≤ T ≤ 6000	12 – 14	14 – 16	12 – 14	12 – 14	12 – 14
	> 6000	14 – 16	16 – 18	14 – 16	14 – 16	14 – 16
45 or 50	< 750	10 – 12	12 – 14	8 – 10	8 – 10	10 – 12
	750 ≤ T < 1500	12 – 14	16 – 20	10 – 12	10 – 14	14 – 16
	1500 ≤ T ≤ 6000	16 – 18	20 – 26	12 – 14	14 – 16	16 – 18
	> 6000	18 – 20	24 – 28	14 – 16	18 – 20	20 – 22
55	< 750	12 – 14	14 – 18	8 – 10	10 – 12	10 – 12
	750 ≤ T < 1500	16 – 18	20 – 24	10 – 12	1 4– 16	16 – 18
	1500 ≤ T ≤ 6000	20 – 22	24 – 30	14 – 16	16 – 18	20 – 22
	> 6000	22 – 24	26 – 32*	16 – 18	20 – 22	22 – 24
60	< 750	16 – 18	20 – 24	10 – 12	12 – 14	14 – 16
	750 ≤ T < 1500	20 – 24	26 – 32*	12 – 14	16 – 18	20 – 22
	1500 ≤ T ≤ 6000	26 – 30	32 – 40*	14 – 18	18 – 22	24 – 26
	> 6000	30 – 32*	36 – 44*	20 – 22	24 – 26	26 – 28
65 or 70	< 750	18 – 20	20 – 26	10 – 12	14 – 16	14 – 16
	750 ≤ T < 1500	24 – 26	28 – 36*	12 – 16	18 – 20	20 – 22
	1500 ≤ T ≤ 6000	28 – 32*	34 – 42*	16 – 20	22 – 24	26 – 28
	> 6000	30 – 34*	38 – 46*	22 – 24	26 – 30	28 – 30

- Total ADT on 2-Lane Rdwys
- Directional ADT on Divided Highways.
- Compare CZ for Aux. Lane vs Mainline
- Show CZ on Typicals

Figure 49-2A

Horizontal Curve Adjustments



$$CZ_c = K_{cz} * CZ_t$$

CZ_t = clear zone on tangent section
CZ_c = clear zone on horizontal curve
L = transition length (ft) = .6V
V = design speed (mph)

K_{CZ} = Fig. 49-2B

CLEAR ZONE TRANSITION FOR CURVE ADJUSTMENT
(Radius ≤ 3000 ft)

Figure 49-2C

Obstruction Free Zone Concept

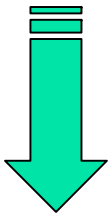
- 3R Projects
- Amount of Obstruction-Free Area next to Rdwy
- Not the same as CZ
- Provide CZ, if practical
- OFZ Width Varies
  - Des Speed, Arterial/ Collector, ADT
- Provide Traversable Ditches
- Level 2 Design Exception

Typical Obstructions

- Trees
- Revetment Riprap Ditches
- Non-Traversable Culvert Ends
- Non-Traversable Ditches
- Concrete Headwalls
- Utility poles
- Bodies of water, permanent water depth>2’
- Non traversable castings

Treatment of Obstructions

1) Remove or Redesign
2) Relocate Outside of CZ
3) Make Breakaway to Reduce Impact Severity
4) Shield with Traffic Barrier
5) Delineate if other Treatments not Practical



Construction Roadside Safety

- IDM 82-4.0 Traffic Control Roadside Safety
  - Reduce Motorist's Exposure to Potential Hazards
  - Maximize Separation
  - Minimize Positive Protection Devices
- Applies to all Project Types
- Analysis & Review required for each MOT Phase

Construction CZ
Fig. 82-4B

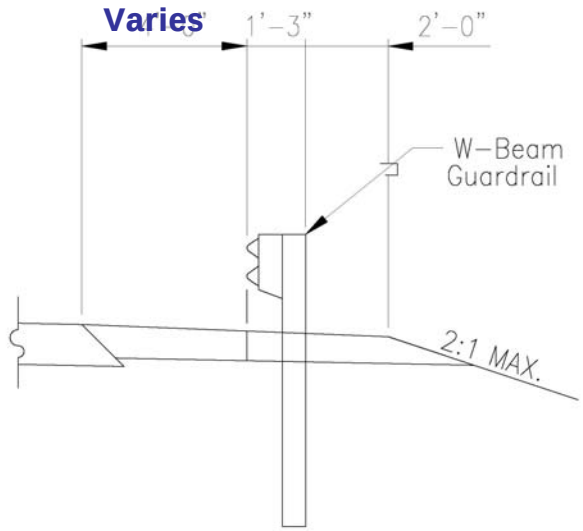
Construction Zone Design Speed	Cut Slopes					Fill Slopes			
	3:1	4:1	5:1	6:1	Flatter Than 6:1	6:1	5:1	4:1	3:1
40 mph or less	8	8	8	8	8	8	8	8	10
45 mph	8	8	8	8	8	8	10	10	12
50 mph	8	10	10	10	10	10	12	13	15
55 mph	8	12	12	12	12	12	13	15	18

Construction Roadside Safety

- Temporary Traffic Barrier
  - Flare Ends Outside of Const. CZ
  - Avoid Openings in Barriers
  - Avoid using in Tapers. Provide Shy Line Offset
  - Check Horizontal SSD thru Tapers/Transitions
- Plan Details
  - Show CZ on Typical MOT Sections
  - Show CZ Design Speed
  - Allowable Flare & Taper Rates
  - Summarize Quantities for each Phase
- Pavement Drop-offs
  - Prefer to Close Lane
  - 3” Max Drop-off at End of Day
  - Temp Wedge at 1:1 next to Lane

GR Lateral Placement

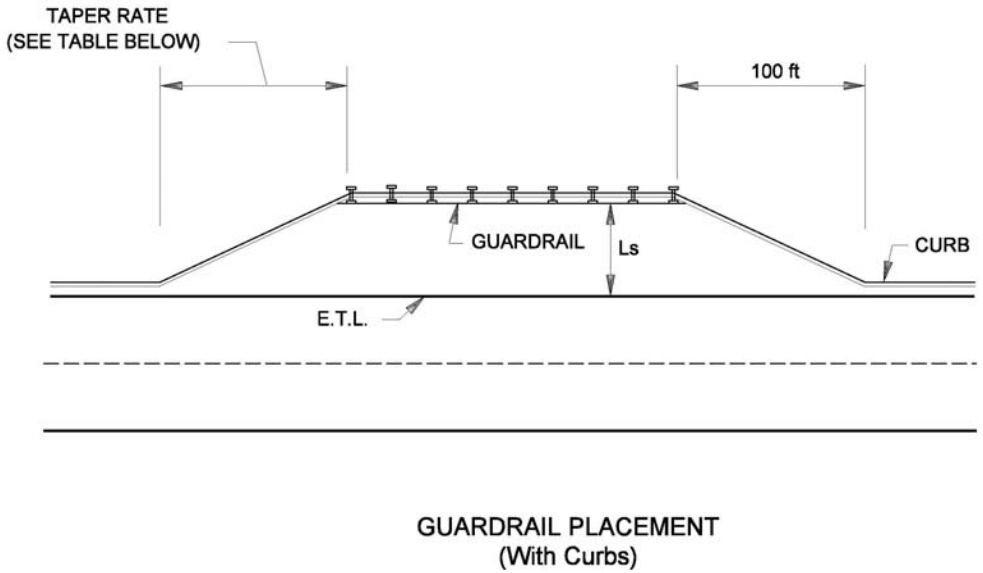
- Place as Far Away from EP as Possible
- Shy Line Offset - Fig 49-5F
- Evaluate Alternatives
  - Additional Cost
  - Reduced Barrier length, Maintenance
  - Accident History
- INDOT Std Revisions Under Review
  - 8’ posts
  - Backfill Material - Cohesive soils not CAB
- Pave Shldr to Face of GR if offset 2’ or less
- If GR offset > 2’, Addt’l 2’ Paved not req’d



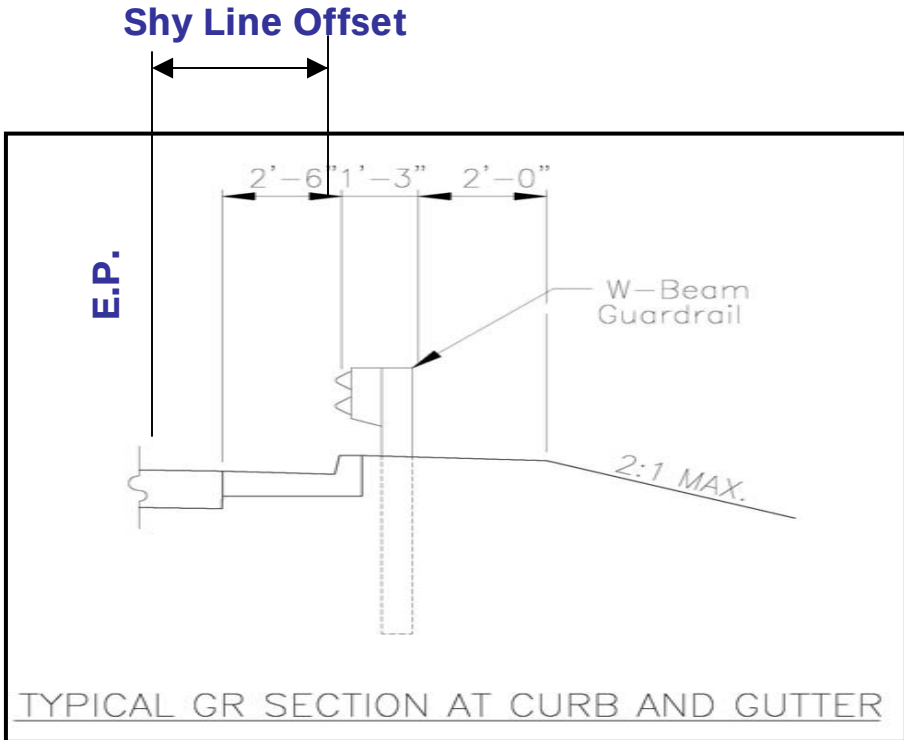
TYPICAL GUARDRAIL SECTION AT SHOULDER

GR at Curb Locations

- Avoid using GR behind curbs
- Best to use Mountable Curb
- Offset GR to Shy Line Offset
- GR at Face of Curb



GUARDRAIL PLACEMENT
(With Curbs)



TYPICAL GR SECTION AT CURB AND GUTTER

Barrier Deflection

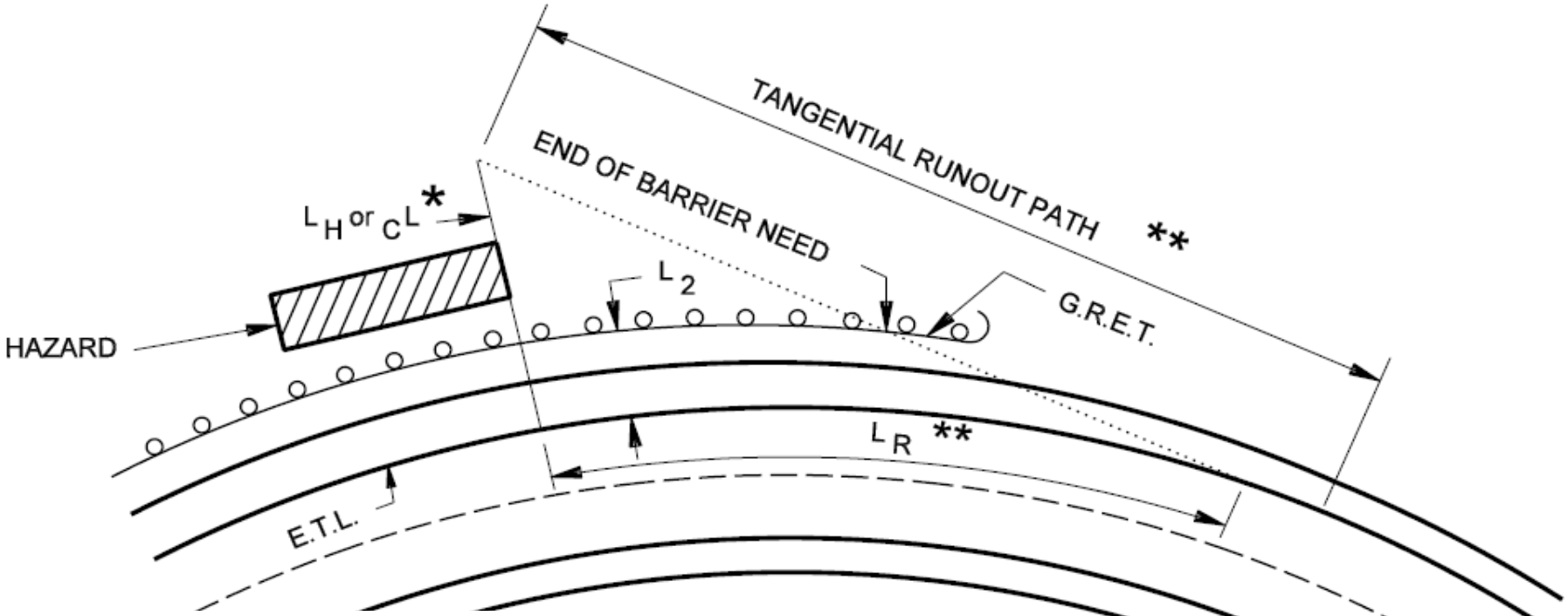
- Clearance Face of GR to Fixed Object
- Based on Dynamic Deflection of Barrier/GR
- INDOT Std Revisions 8’ posts & Backfill
- Check for Fixed Objects and Drop-offs

BARRIER DEFLECTIONS

Figure 49-5A

TYPE OF RAIL	CRASH TEST (see below)	MAXIMUM DYNAMIC DEFLECTION*
Guardrail, 6’-3” Post Spacing	2	4.30 ft
Guardrail, 3’-1½” Post Spacing	2	3.30 ft
Guardrail, 1’-6¾” Post Spacing	2	2.80 ft
Guardrail, Thrie-Beam, 6’-3” Post Spacing	2	3.75 ft
Guardrail, Thrie-Beam 3’-1½” Post Spacing	2	3.00 ft
Guardrail, Thrie-Beam, 1’-6¾” Post Spacing	2	2.50 ft
Guardrail, Type B, 12’-6” Post Spacing	1	7.55 ft
Guardrail, Type B, 6’-3” Post Spacing	1	4.30 ft
Guardrail, Type B, 3’-1½” Post Spacing	1	3.30 ft
Guardrail, Type B, 1’-6¾” Post Spacing	1	2.80 ft
Concrete Median Barrier (CMB)	1	0.00 ft

GR Need Horizontal Curves



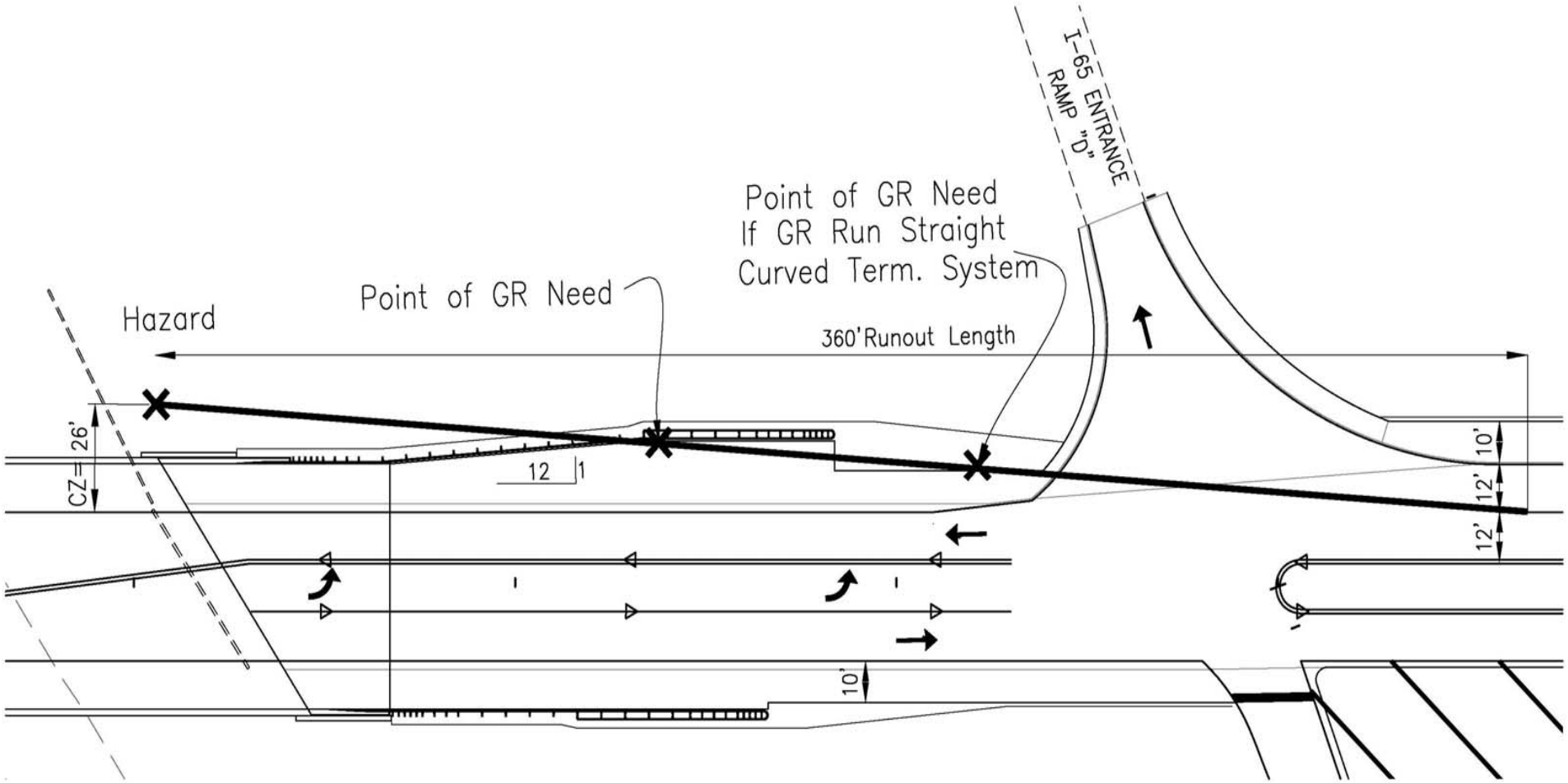
EXAMPLE OF BARRIER DESIGN
(Fixed Object on Horizontal Curve)

* -WHICHEVER IS LESS
** -WHICHEVER REQUIRES LESS GUARDRAIL

Figure 49-5I

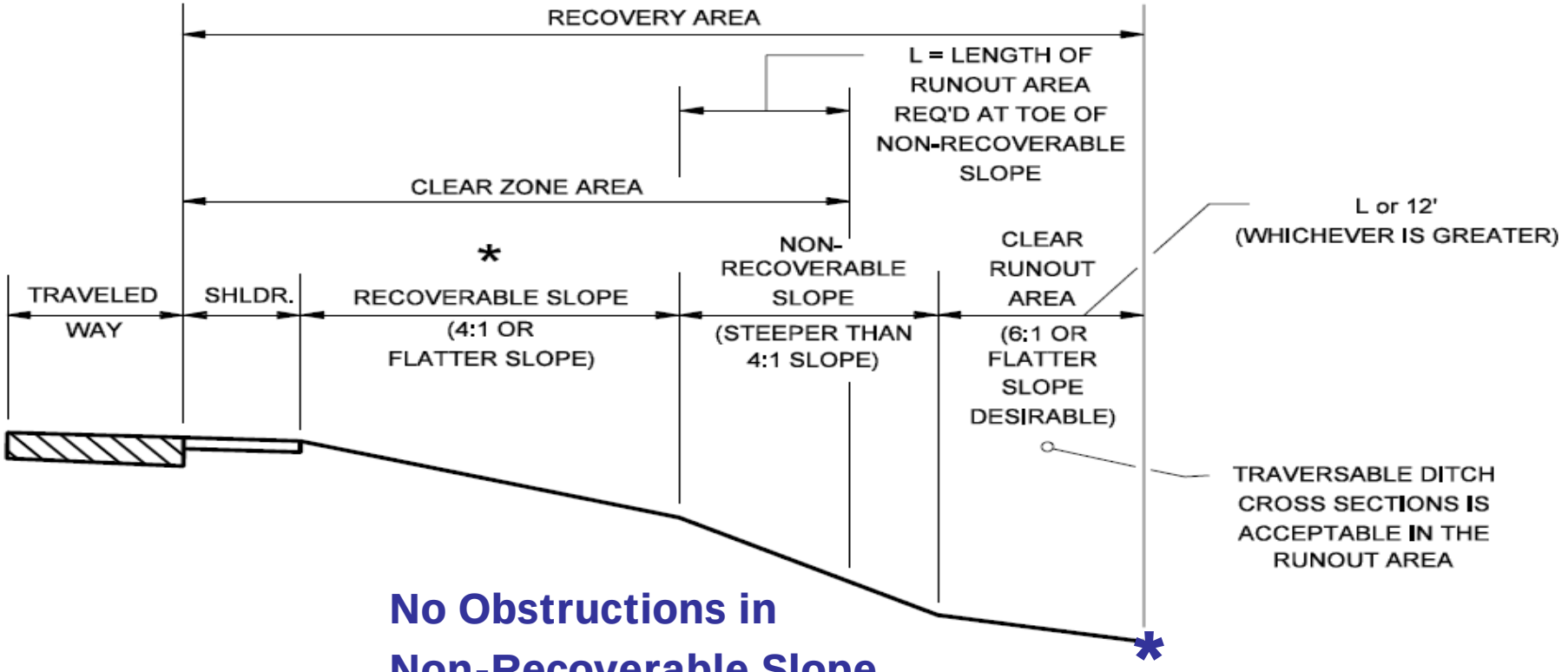
GRAPHICAL SOLUTION REQUIRED
INVESTIGATE BOTH ALTERNATIVES
USE SHORTEST LENGTH OF NEED

GR Alternate Offset



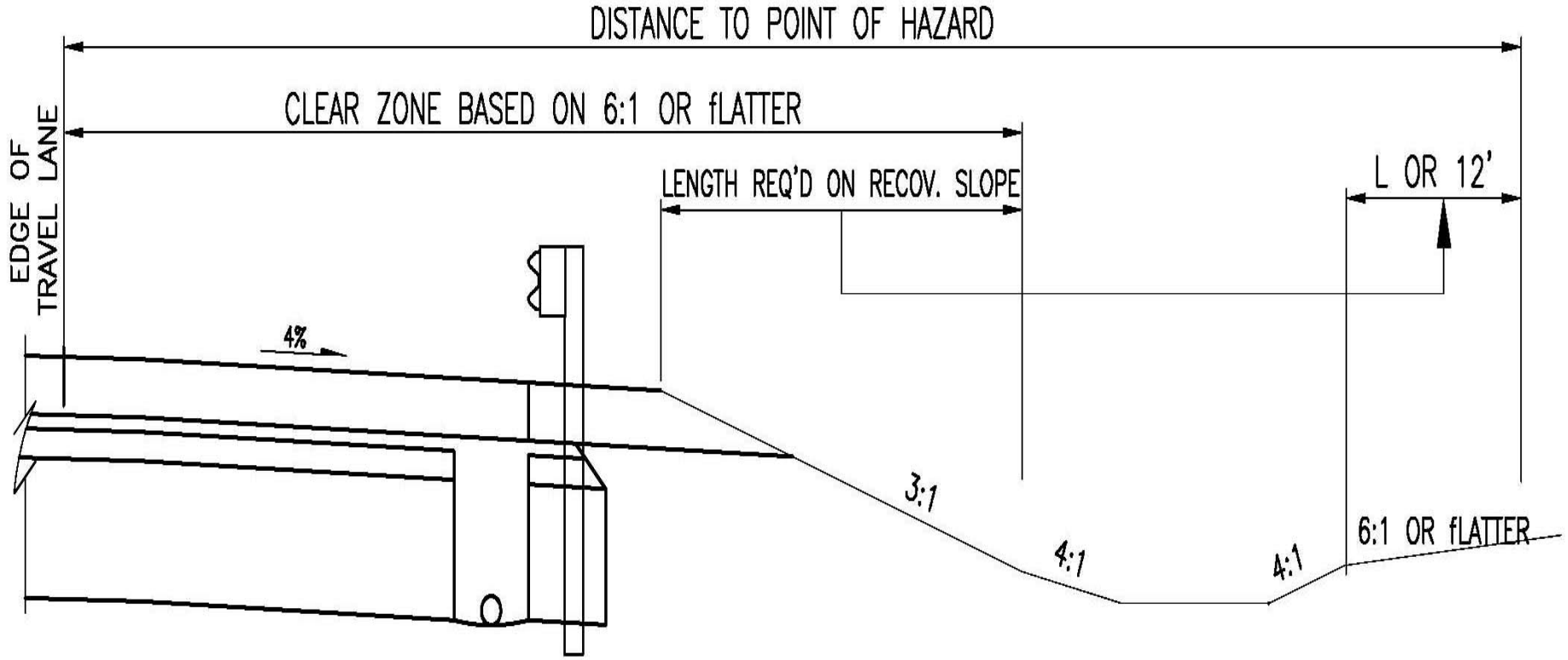
Tapered GR Example

Non-Recoverable Slopes



Non-Recoverable Fill Slope

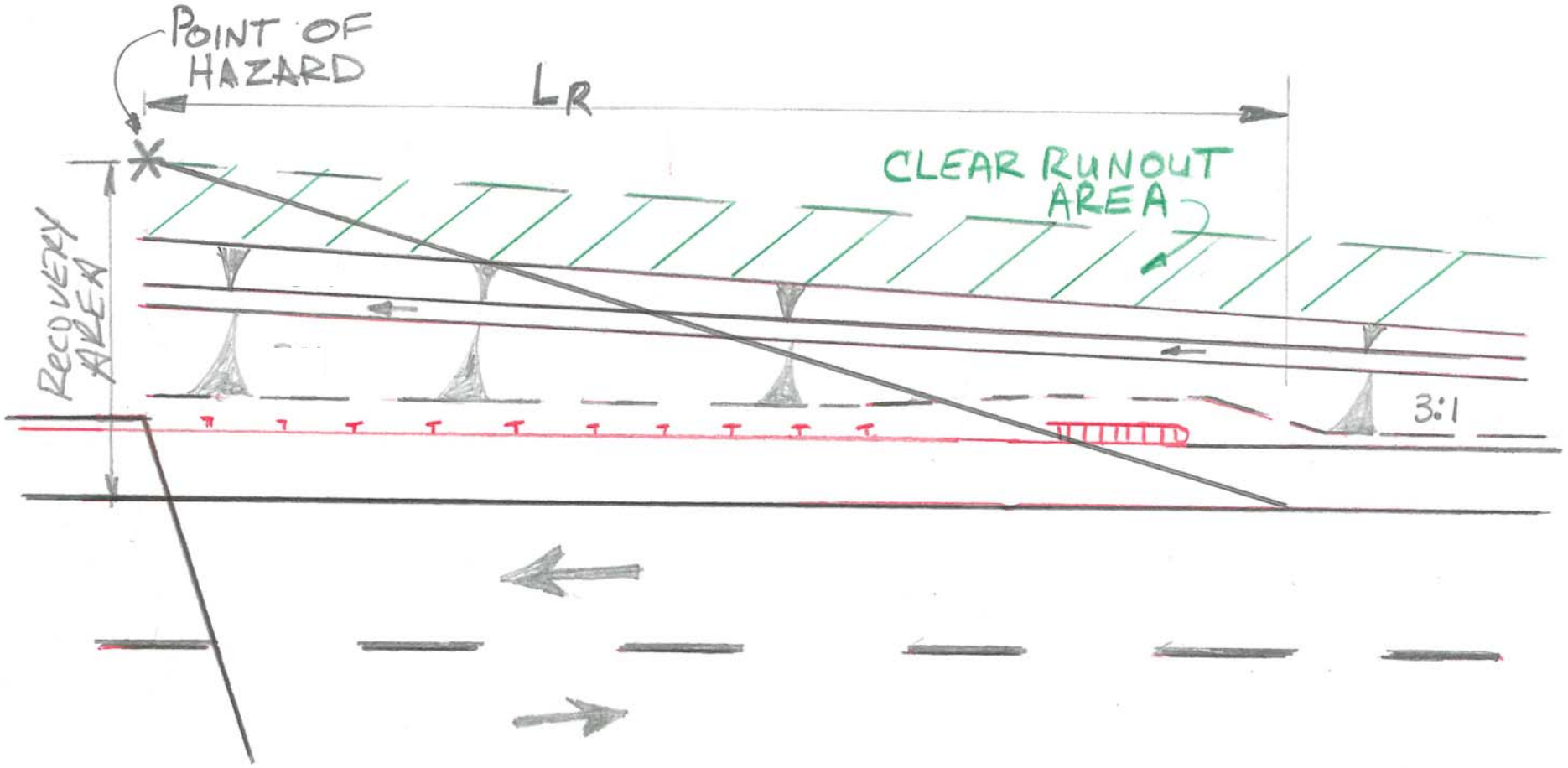
GR Design Non-Recoverable Slopes



Traversable Ditch
Cross Section Preferred

Example GR Design with 3:1 Slopes

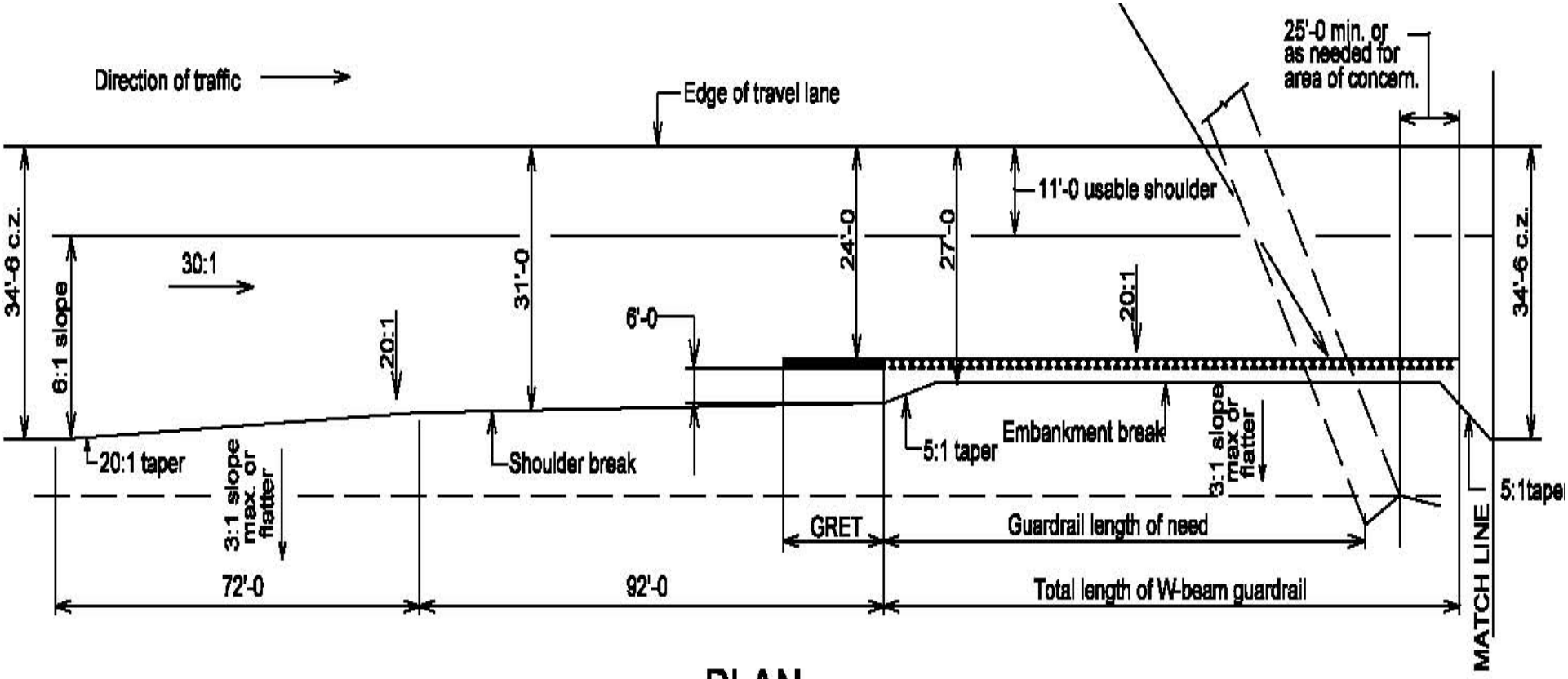
GR Design Non Recoverable Slopes



Example GR Design with 3:1 Slopes

GR at Large Structures

- New Construction 70 MPH Des Speed
- New Alignment – Divided Hwy
- Perpetuate CZ thru Structure



PLAN

Drainage Structures

- 1’ to 5’ ø Cross Pipes
  - Use Safety Metal ES
  - Skew > 10 Deg Use GBES
- 5.5’ ø and Larger – End Inside CZ
  - If Cost Effective, provide Traversable ES
  - Desirable Place GR at 12’ from EP
  - Use Nested GR if Low Fill
- 5.5’ ø and Larger – End Outside CZ
  - Desirable Place GR on slope away from EP
  - Desirable Place GR at 12’ from EP
- Ditch Inlets
  - E-7 and F-7 Not Within CZ
  - Use Pipe Catch Basin
  - Other Type with less than 4” Protrusion

Design Exceptions

- Level 2 DE
  - CZ and OFZ
  - Provide Brief Rationale
  - Alternates Considered
- Document to File
- Submit to Project Manager
- Discuss at Field Check
- Local Projects need LPA Sign-off

Common Mistakes & Omissions

- Incorrect CZ Distance
- Incorrect CZ Adjustment
- CZ Not Shown on Typical Sections
- Obstructions within OFZ or CZ
- Obstructions not Shielded or Traversable
- Non-Traversable Ditches
- Design Exceptions Not Documented
- Using less than 100’ of Nested GR

Practice Pointers

- Perform CZ review
- Plot CZ/OFZ on Plans
- Provide Consistent CZ
- Determine if any obstructions within CZ
- Determine/Verify Corrective Action
- Discuss CZ/OFZ at Field Checks
- Document Deficiencies
- Check MOT Plan and CZ

ROADSIDE SAFETY

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GUARDRAIL DESIGN